

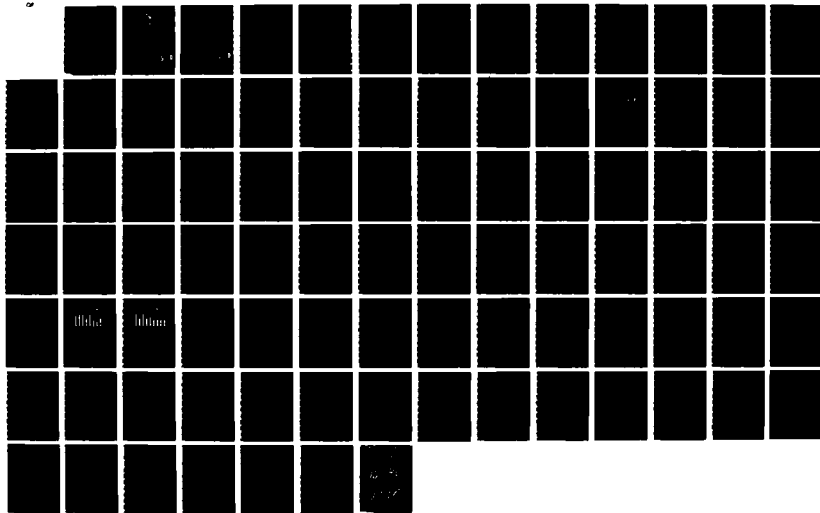
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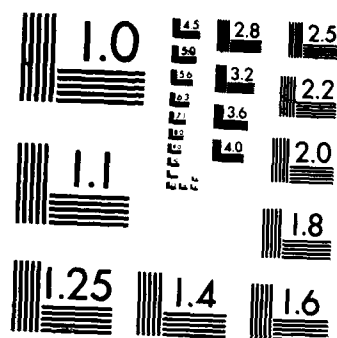
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AN EVALUATION OF THE EFFECTIVENESS
OF THE INDUSTRIAL MODERNIZATION
INCENTIVES PROGRAM (IMIP)

THESIS

David E. Spenny
Captain, USAF

AFIT/GLM/LSM/86S-81

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OF THE INDUSTRIAL MODERNIZATION
INCENTIVES PROGRAM (IMIP)

THESIS

Presented to the Faculty of the School of Systems and Logistics
of the Air Force Institute of Technology
Air University
In Partial Fulfillment of the
Requirements for the Degree of
Master of Science in Logistics Management

David E. Spenny, B.S.
Captain, USAF

September 1986

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Acknowledgements

The completion of this thesis could not have been possible without the help of numerous individuals. First, my sincere appreciation and gratitude to Dr. William C. Pursch, my thesis advisor, for his understanding, guidance and support. Additionally, I appreciate the technical assistance that Mr. Fred Brooks of the Aerospace Industrial Modernization Office, AFSC/PMI, at Wright-Patterson Air Force Base gave me during my research effort. Further, Jackie McHale and her excellent administrative abilities eased the burden of the "AFIT Style Guide Blues."

Finally, my deepest appreciation to my wife, Sally, for her continued patience and support that made this effort possible.

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Abstract

The Industrial Modernization Incentives Program (IMIP) is the first significant DOD attempt to provide a catalyst for defense contractors to modernize the defense industrial base. IMIP evolved from the Air Force's Technology Modernization (TECHMOD) program that was designed to reduce weapon systems cost and strengthen the industrial base. While IMIP is maturing since its 1982 beginnings, standardized criteria for evaluating its effectiveness have been lacking.

This second stage of research is built upon the study completed by Cooper and Houck, Measuring the Effectiveness of the Industrial Modernization Incentives Program. They identified nine criteria that were validated as useful tools in evaluating the effectiveness of IMIP. During the second stage, these criteria were applied to selected IMIP projects to see if IMIP reduces weapons systems cost and modernizes the U.S. defense industrial base. The nine criteria were rephrased into nine investigative questions. Results of the research indicate that two of the nine should always be used on a selected basis depending on the project being evaluated.

AN EVALUATION OF THE EFFECTIVENESS
OF THE INDUSTRIAL MODERNIZATION
INCENTIVES PROGRAM (IMIP)

I. Introduction

General Issue

The U.S. defense industries have been reluctant to modernize their plants with up-to-date manufacturing technology. The lack of capital investments by defense industries is a "major contributor to the weakening of the United States' defense industrial base" (9:1). The reluctance by defense industries to modernize in the 1970s is even more alarming when we consider the Soviets have realized a huge growth in their nuclear and conventional capability during the same period. The health of the U.S. defense posture during this time period may best be described as "the industrial base is not capable of surging production rates in a timely fashion to the increased demands that could be brought on by a national emergency" (6:8). Additionally, Richard H. Ichord, Chairman of the Defense Industrial Base Panel, warns, "there has been a serious decline in the nation's defense industrial capability that places our national security in jeopardy" (23:2). Perhaps Lieutenant General Stansbury explained the senior military concern best by stating:

It's no secret that this nation's industrial base is in bad shape. Congressional hearings have produced alarming testimony from a succession of government, military, and industrial authorities, all lamenting the decline of the "arsenal of democracy" from its former preeminence in industrial might. The well published woes of the automobile, steel and shoe industries - and of a host of less noticeable ones as well - are real. Unless the across-the-board industrial declines are checked, the ability of our armed forces to act as credible instruments of national policy will be seriously, perhaps fatally endangered. (25-2)

This concern has resulted in an integrated, significant attempt to revitalize the U.S. defense industrial base.

The foundation for this revitalization process is the Department of Defense (DOD) Industrial Modernization Incentives Program (IMIP), of which the Air Force Technology Modernization (TECHMOD) program is a part (19:23). The IMIP began as a test program in 1982 as a result of Initiative #5, Capital Investment, of the DOD Acquisition Improvement Program. Initiative #5 was to "encourage through a variety of mechanisms, capital investment by DOD contractors to increase their productivity" (26:A-B). The IMIP was developed as

a joint venture between the government and industry to accelerate the implementation of modern equipment and management techniques in the industrial base . . . IMIPs are implemented where competitive market forces are insufficient to bolster independent contractor modernization. They are also implemented where significant benefits such as cost reduction, elimination of production bottlenecks, improved quality and reliability, and improved surge capability can be expected to accrue to the government. (1:1)

The IMIP is defined by Secretary of Defense Weinberger as "the number one DoD initiative to the White House Conference on Productivity" (15:26).

The objectives of the IMIP are both short and long term.

The short term objective is to reduce the cost and lead times and increase the quality of manufacturing through productivity gains. The long-term objective is to have a healthy, strong industrial base to meet surge and mobilization requirements should a conflict/war arise. (1:1)

Now, four years after implementation of the IMIP, the management question is: Does the IMIP reduce weapon systems cost and help to modernize the U.S. Industrial Base?

Specific Problem

While the answer to the management question may seem easy to develop, it is indeed more complex than it seems.

The analysis of the Industrial Modernization Incentives Program (IMIP) extend beyond basic cost analysis. In addition, the effect of the IMIP upon crucial components of the acquisition process such as free and open competition, degree of benefit to both prime and subcontractor levels, and defense industrial "surge" and "mobilization" capabilities must also be considered when determining the overall success of the IMIP in meeting its objectives. (9:5)

One of the primary reasons for the difficulty in analyzing the IMIP impact has been the inability of a standardized DOD evaluation program for industrial modernization. This glaring deficiency was identified in three General

Accounting Office (GAO) reports in 1979, 1983, and again in 1984 (9:5).

The latest GAO review of the IMIP found three areas of concern. First, the GAO found that the DOD expected to save \$6 billion over the next ten years (see Appendix A). The primary problem is that these estimates may not be entirely accurate. The GAO found the early projected savings estimate decreases significantly as the projects move into the final stages of the program. Further, the GAO found that the Office of the Secretary of Defense (OSD) and different armed services have not developed guidance on how to input IMIP benefits in weapons systems budgets (13:4-8).

Second, the GAO found that the DOD steering group, established in 1982, did not develop a plan for significant issues, including "1) the effects of, or need for funding and, 2) the differences in IMIP efforts with prime contractors versus subcontractors" (13:27). Additionally, the GAO found that business arrangements for each IMIP project will have to be designed individually and that "continual evaluation and oversight" is needed due to the complexity of the problem (13:28).

Third, the GAO concluded that a planning and programming process would help decide how IMIP funds should be allocated and how to best track contractor performance. The GAO acknowledged that the Air Force was progressing

well in this area, but emphasized the need for further work (13:28).

The GAO findings indicate the need for a standardized IMIP evaluation program that examines both a qualitative and quantitative approach. The IMIP may reduce weapons system acquisition cost, but its true value could be in its ability to rejuvenate the U.S. defense industrial base.

Research Objective

The objective of this research is to complete the second of an original two stages of research to see if "the IMIP/TECHMOD is reducing acquisition cost of major weapon systems while maintaining free and open competition and assuring defense industrial base surge/mobilization capability" (9:6). In a 1985 Air Force Institute of Technology thesis, Measuring the Effectiveness of the Industrial Modernization Incentives Program (IMIP), Cooper and Houck completed stage I of the research effort by identifying nine evaluation categories as viable criteria for evaluating the effectiveness of the IMIP. The objective of this second stage of research is to apply the nine evaluation categories to selected IMIP projects and analyze the effectiveness of the IMIP in meeting its stated goals.

Research Question

During this second stage of research, the hypothesis that the IMIP reduces weapons systems cost and modernizes the U.S. defense industrial base will be tested. The following investigative questions will guide this research effort.

1. Has IMIP reduced acquisition cost?
2. Has IMIP improved productivity?
3. Has IMIP improved item quality?
4. Has IMIP improved state-of-the-art technology?
5. Has IMIP increased the degree of technology transfer?
6. Has IMIP increased surge/mobilization capability?
7. Has IMIP reduced production lead times?
8. Has IMIP increased plant modernization?
9. Has IMIP reduced critical material usage?

These investigative questions were drawn from the stage I research completed by Cooper and Houck (15:100).

Summary

The U.S. defense industries have been reluctant to modernize their plants with new technology. This reluctance has increased weapon systems cost and affected the wartime surge capability of the U.S. defense industrial base. The Department of Defense Industrial Modernization Incentive Program (IMIP) and the Air Force Technology Modernization Program (TECHMOD) were developed to encourage

defense contractors with contractual and shared savings incentives to modernize industrial facilities. This modernization attempts to reduce major weapons systems cost and to strengthen the defense industrial base.

Since implementation of the modernization program, an instrument to evaluate the effect of IMIP has not been developed. Nine evaluation categories were found to be viable criteria to evaluate the program. These criteria require application to IMIP projects to measure the effect IMIP is having upon major weapons systems cost and the defense industrial base.

The objective of this research is to apply the nine evaluation criteria to selected IMIP projects. The results will be analyzed to determine whether or not the IMIP reduces weapons systems cost and modernizes the U.S. defense industrial base.

Chapter II, Literature Review, will provide the background information required for this research. An examination of the defense industrial base and its deterioration is provided. The IMIP and other related programs are then discussed. Finally, a synopsis of the findings by Cooper and Houck's research, Measuring the Effectiveness of the Industrial Modernization Incentives Program (IMIP), is provided. Chapter III, Research Methodology, identifies the techniques used in this research. An explanation of the population and data collection techniques is provided.

Chapter IV, Analysis of Findings, documents responses to the interview questions. The data is categorized by each of the nine evaluation categories and is subcategorized by whether the response was from a contractor or subcontractor. Chapter V, Conclusions, summarizes the data for each category, identifies the merit of each category in evaluating the IMIP, and provides recommendations for additional evaluation of the IMIP program.

II. Literature Review

Defense Industrial Base Composition

The U.S. defense industrial base is a vital element in the security and national defense of the nation. However, this essential element of our defense posture is difficult to define (8:41). Yet, a basic understanding of the defense industrial base is necessary to understand the reasons for the DOD Industrial Modernization Incentives Program (IMIP). A generic description of the defense industrial base is:

that part of the total privately-owned and government-owned industrial production and maintenance capacity of the United States, its territories and possessions, as well as capacity located in Canada, expected to be available during emergencies to manufacture and repair items required by the military services. (10:343)

A description that better typifies the U.S. Air Force version of the defense industrial base is:

the industrial base from which, in a national emergency, we will require the capability to rapidly produce large numbers of technologically sophisticated weapon systems and spare parts. (8:45)

The role of the defense industrial base is to provide replacement parts for current weapon systems, discover new technology, and incorporate this technology into the production of new weapon systems. The process must be done

efficiently, at reasonable cost, and result in sufficient quantity and quality of weapon systems to meet the actual threat. The ability of the industrial base to accomplish the above tasks results in a relative degree of military capability. This degree of military capability is a functional part of U.S. defense posture.

There are three general states of production on a continuum scale. These states are normal, surge and mobilization. Normal production is the day-to-day operation which typifies the production level in normal peacetime operations. Surge refers to the increased production rates within a year over normal peacetime rates in response to a perceived threat or requirement. A surge can be defined as the "expansion of military production within a peacetime environment" (7:40). The additional production rate is accomplished by using the current underutilized production capacity. Mobilization refers to a drastic increase in production rates in response to a national crisis by converting civilian industrial capacity into military production. Mobilization is defined as

the transformation of industry from its peacetime activity to the fulfillment of the military program necessary to support the national military objectives. It includes the mobilization of materials, labor, capital, productive facilities, and contributory items and services essential to the military program. (10:344)

A surge is in response to a short-term scenario, while a mobilization is a long-term effort in response to a

"wartime situation" (7:41). A production rate increase of 200 percent over a 36-month period would be expected under a defense industrial base mobilization (7:40-41).

Historical Perspective

During the years preceding World War II, Americans were secure in their isolation from the world's problems. The United States was one of the major industrial powers in the world, but the industrial might was concentrated on consumer goods and services rather than military weapons (29:208). Although the U.S. government stressed neutrality, its sympathy was with Great Britain. This sympathy became official in 1941 when Congress passed what is known as the Lend Lease Act (21:2-9). The legislation provided for the expansion of, and conversion to the "arsenal of democracy" for defense industries. This conversion process exhibited "unparalleled" advances in productivity (2:74).

The U.S. defense industrial base continued to expand throughout the war. The industrial capacity of the U.S. eventually proved itself to be far overwhelming the Axis alliance (22:8). The U.S. emerged from the war as the major industrial power in the world, which assisted in sustaining postwar economic growth (2:118).

During the postwar period, the infrastructure of the defense industry remained intact. Defense contractors recognized both the need and profit potential of supplying

weapons systems to the government. Military procurement and its specialized nature led to a government-directed defense industry (28:27). The tremendous buildup of the U.S. defense industrial base that resulted from World War II left the defense industry in a healthy position as the Korean conflict erupted. It wasn't until the post-Vietnam War period that questions concerning the status of the defense industrial base surfaced (2:21).

In 1976, the Defense Science Board Task Force on Industrial Readiness reported serious deficiencies in the defense industry that negatively impacted national security plans and objectives. In 1980, the seriousness of the situation was documented in The Ailing Defense Industrial Base: Unready for Crisis by the House of Representatives Committee on Armed Forces. The Committee found that "the condition of the defense industrial base has deteriorated and is in danger of further deterioration in the coming years" (27:1). In 1982, Gansler warned in The Defense Industry, that

the industrial base of U.S. defense is becoming economically inefficient in the production of defense material and strategically unresponsive in terms of the production speedup required to meet an emergency. (13:4)

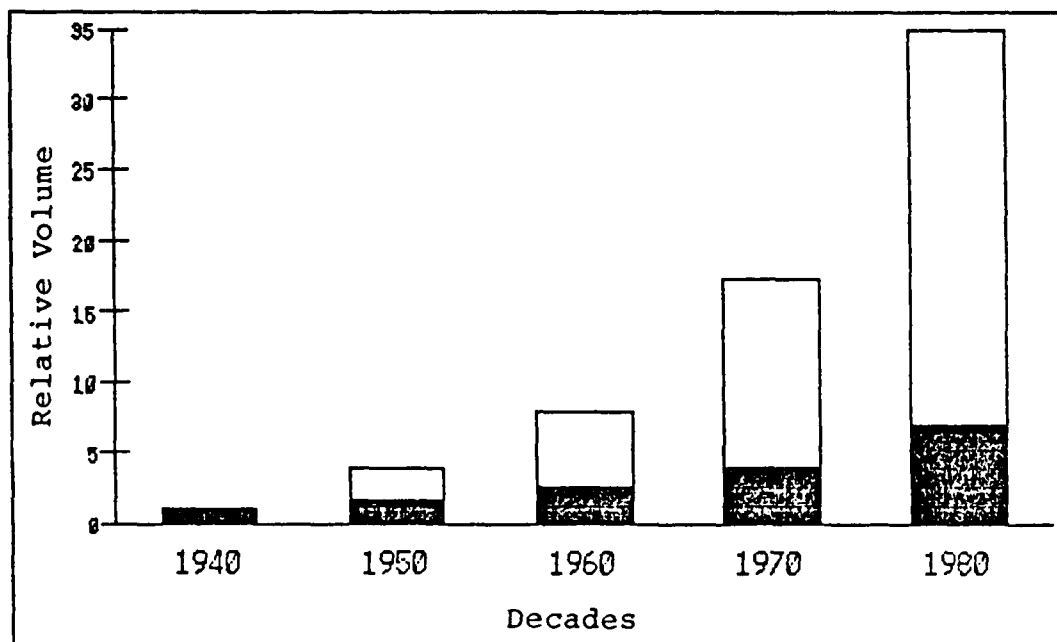
Defense Industry Deterioration

Over the last ten years, both commercial and defense industries have seen a lack of productivity growth

(22:210). Antiquated plants and equipment, combined with declining investment in the defense industry by the private sector, provide the root cause of productivity problems. The lack of emphasis on increased productivity has led to an escalation in the cost of modern weapon systems and excessive leadtimes in the acquisition cycle. Increased cost coupled with the loss of competitiveness in the defense industry provide a circular trend that threatens the DOD's "ability to procure military equipment in a timely, efficient and economical manner" (27:13).

Considerable turbulence within the defense base has resulted from the continued loss of industrial productivity. The situation is compounded further by evidence of an actual shrinkage of that base (5:75-76). Studies indicate that the majority of firms contracting with the DOD prefer the lucrative business available in the more stable commercial sector (27:13). Current investment trends in the private sector are indicative of their reluctance to invest capital in what they perceive to be a losing proposition. Instead, they continue to pursue "a strategy of low investment with high returns at the risk of long-term growth" (3:2).

American industries have shown a tendency to fail to anticipate and take advantage of available technologies. Figure 1 shows the growth of technology in the U.S. and the rate at which that technology has been implemented.



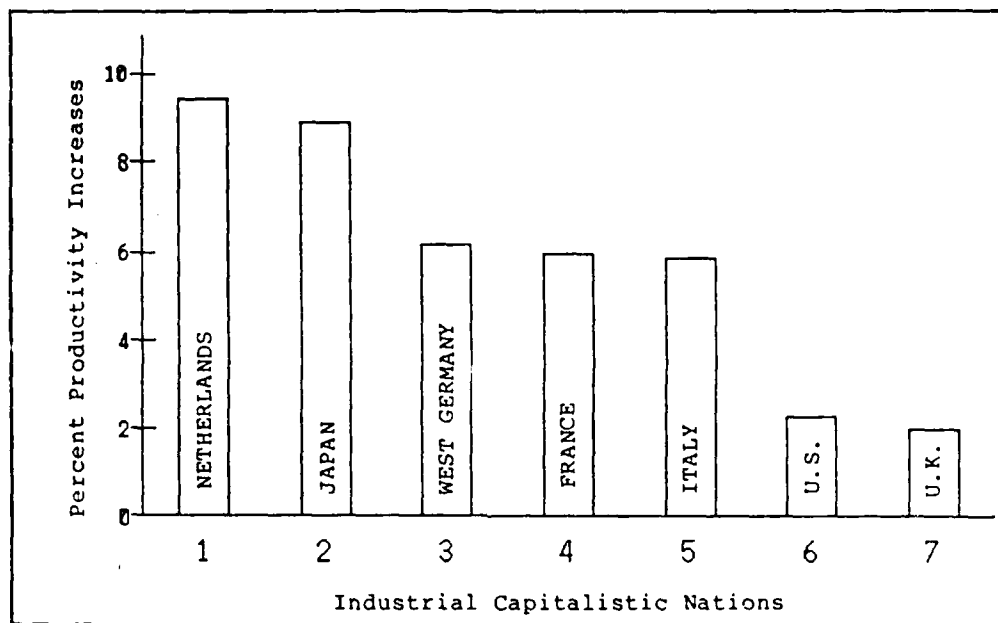
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- Growth of Technology
- Implementation of Technology

Note: Figures based on average 5% annual growth rate.

Figure 1. Implementation of Technology, 1940-1980

As indicated, the introduction of new technologies into factories and plants has not kept pace with the rate at which the technology was developed. Figure 2 shows the end result of the gap. U.S. industries are losing ground in the productivity arena. Productivity in the U.S., as measured by relative growth of output per labor hour, has increased, but at a slower rate as compared to other competitive nations. The slow rate of productivity increase makes U.S. firms less competitive in the world market (12:57).



(4:44)

Figure 2. Growth of Output per Labor Hour, 1968-1978

The U.S. continues to be a world leader in productivity, but the decreasing growth rates indicates a declining industrial base. Reports indicate the U.S. is "dead last in productivity improvements among all industrialized nations of the world" (27:16). While the U.S. defense industry may be one of the best in the world, the positive aspects of the defense industry are the result of investments made in the 1950s and 1960s (27:17).

Causes of Deterioration. The Chairman of the Defense Industrial Base Panel, Richard H. Ichord, identified one of the major reasons for the deterioration of the industrial base as the "lack of a long-range strategic plan for industrial preparedness at the Department of Defense"

(27:20). As Cooper and Houck explained in their thesis, Measuring the Effectiveness of the Industrial Modernization Incentives Program, "Mr. Tom Murrin, President, Westinghouse Public Systems, suggests that there is, indeed, a lack of commitment and that it is not restricted to only the Department of Defense" (9:19). The Executive Branch also has responsibility in strategic planning. "The Reagan administration itself will have to establish a clear industrial mobilization policy" (17:13). Cooper and Houck also noted that the Industry Advisory Council to the Secretary of Defense found the cause of the defense industrial base deterioration to be

the DOD not being able to adequately define and specify its mobilization requirements in a timely, realistic manner. . . . Requirements . . . are the foundation for industry decisions about plant maintenance or expansion and capital investment. (20:56)

Koradbil subscribes to the belief that defense leaders do not treat weapons systems and the industrial base as synergistic functions. He then states, "If production facilities are outmoded, product design will be inhibited" (16:6). Thus, if planners fail to ensure that the industrial base is modernized with new technology, the new weapon systems will be restrained by our industrial capacity and not industrial ability (16:29).

Subcontractor Problems. The deterioration of the defense industrial base not only has affected the prime

contractors, but has had a more pronounced effect on the subcontractor tier. Defense-related subcontractors tend to be smaller companies with fewer than 250 employees. These subcontractors are the most susceptible to the competitive market. This competitive nature leaves them vulnerable to the difficulties of productivity and industrial planning.

Subcontractors generally do not have access to the financial resources available to prime contractors. Subcontractors do not have as much access to government supplied resources such as funds, plants and equipment. Subcontractors must provide their own sources of capital, which forces them to finance their debt in the open market at higher rates of interest than that charged to prime contractors (12:137-138).

Technical difficulties also provide problems for subcontractors. Problems due to inadequate capabilities, lack of skilled manpower, performance specifications, and the requirement for specialized equipment are compounded at the subcontractor level (12:149-150).

To a great extent, the modern capital equipment now available is appropriate only for firms of substantial size. Smaller manufacturers, because of the length of their production runs and their limited financial resources, are less able to incorporate changes in production technology. (5:119).

Technology Modernization

The Air Force Technology Modernization (TECHMOD) program is a partnership effort between the DOD and contractors in fulfilling DOD contracts. The thrust of this partnership is to implement new and existing technology into the industrial environment to increase productivity and reduce system acquisition cost. This partnership effort is based upon a joint commitment for analysis of the production facility, modernization of the facility, and a shared production cost savings.

Cooper and Houck noted that the DOD "commitment to improve industrial productivity began with the 'Profit 76' study" and continued with the "Payoff 80" study (9:32). However, these studies failed to recommend specific implementation directives for TECHMOD programs.

The Air Force Systems Command (AFSC) office has implemented "contracting for productivity" and "technology modernization" programs to increase capital investments in the private sector. "Productivity contracting uses contractual arrangements such as multiyear contracts, capital investment incentives, (and) contractual provisions" to increase productivity (9:32). Technology modernization efforts in the Air Force are provided in two separate programs: the Manufacturing Technology (MANTECH) program and the Industrial Modernization Incentives Program (IMIP). IMIP evolved from the TECHMOD program.

MANTECH Program. The Air Force MANTECH program began in 1947. The necessity to improve basic industrial capability in the aerospace industry led defense proponents to MANTECH. MANTECH is primarily concerned with investigating manufacturing technology. The overall goal of the program is to reduce weapon system cost and to improve productivity. Its focus is the development and implementation of new or improved technology.

The MANTECH effort is primarily aimed at providing technical expertise and "seed money" in the manufacturing function to enhance productivity of a certain process or function. It is a program designed to take advantage of state-of-the-art innovations. The Air Force Wright Aeronautical Laboratory Materials Manufacturing Technology Division is responsible for the administration of the MANTECH program. The laboratory is the lead Air Force agency for ensuring new manufacturing technology is available for Air Force requirements (1:2).

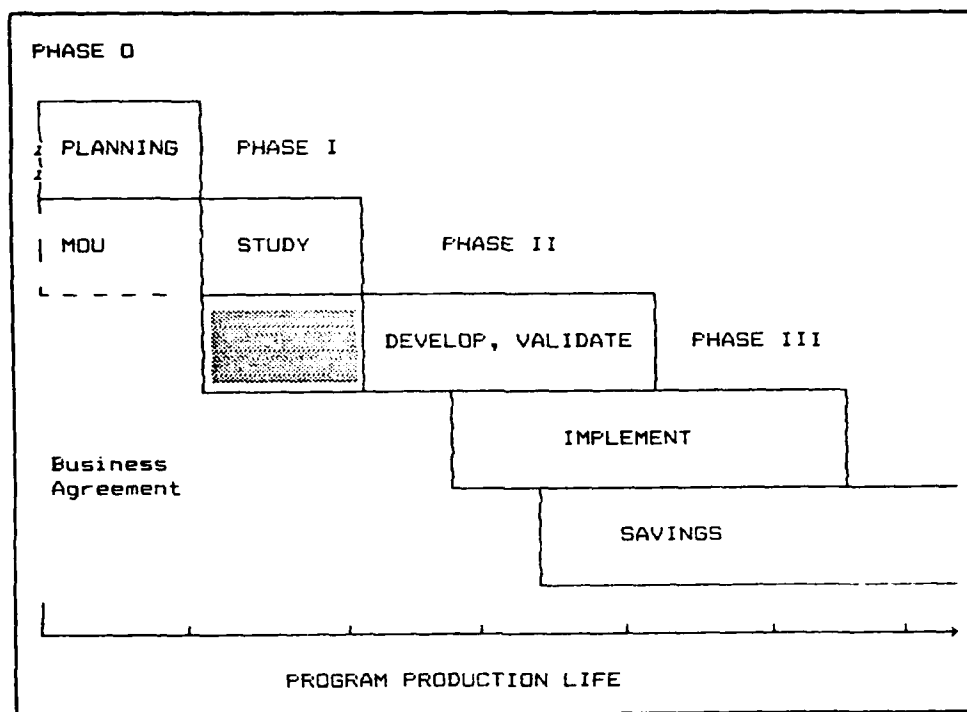
The MANTECH program is a long-term program that has shown merit for increasing productivity and reducing weapon system acquisition cost. Yet, by itself the MANTECH program does not ensure that new or improved technologies are combined with production processes to increase productivity (10:11). The MANTECH program has had numerous successes, but these successes have been with individual processes or production events. The direct link between

new technologies and an integrated production application was not apparent (25:15). To fill this void, the TECHMOD program was developed in 1977 to extend the benefits of the MANTECH program across the production spectrum.

TECHMOD Program. The TECHMOD program is a total factory or production improvement program. The Air Force TECHMOD program was the forerunner to the DOD IMIP now in effect. The major difference between MANTECH and TECHMOD is that MANTECH is primarily concerned with individual applications of new or improved technology, whereas TECHMOD contains broader applications to increase productivity throughout the total factory environment.

It should be noted that as present TECHMOD contracts expire they are converted to IMIP projects to reduce terminology differences. For the purpose of this research, the background of both TECHMOD and IMIP will be presented in this chapter. Currently, a TECHMOD project within the Air Force is referred to as an IMIP project.

TECHMOD is a separate agreement with the contractor that provides the contractor with potential investment. This potential investment or "seed money," coupled with the contractor's investment is designed to provide long-term growth and productivity increases on a factory-wide approach (9:36). The TECHMOD project is a three-phased process, usually preceded by a planning period between the Air Force and potential TECHMOD contractors (see Figure 3) (1:3).



(1:2)

Figure 3. IMIP Phasing

Phase I of the TECHMOD effort is a study of what is presently in place at the contractors facility and an evaluation of what improvements can be made. Phase I has been described as

a "top down factory analysis" which evaluates the needs of the overall facility and identifies candidate manufacturing technologies/modernization opportunities which are applicable to the types of systems produced in the facility. (1:1)

If the Phase I analysis is favorable for a TECHMOD arrangement, a negotiated "business arrangement" between the Air Force and the contractor will result. This

arrangement may take many forms from a separate TECHMOD contract to the addition of clauses onto ongoing production contracts. Some of the considerations involved in the negotiation include incentives, benefit sharing arrangements, and return-on-investments. Funding for Phase I may be provided by the Air Force as "seed money" or from contractor investment or both. The Phase I business arrangement establishes the framework to Phases II and III (1:2).

Phase II is basically a development and validation phase.

Phase II is the development of the enabling technologies and design and fabrication of the factory modernization enhancements. Phase II also identifies implementation plans, specifies hardware/software operational requirements and validates specific applications through method demonstrations. (1:1)

Phase III is the implementation of TECHMOD projects in the contractor's facility, including the purchase and installation of equipment by the contractor to "implement those Phase II candidates that demonstrate the highest potential payback and other 'off the shelf' equipment to be used in the overall plant modernization" (1:1). As shown in Figure 3, Phase III may begin while Phase II is ongoing. This overlap provides for a transition necessary to ensure the success of the program. Once Phase III is initiated and production systems become operational, cost savings and additional TECHMOD objectives can begin to be quantified.

Industrial Modernization Incentives Program

In 1981, Frank C. Carlucci, then Secretary of Defense, chartered five working groups composed of representatives from the Office of the Secretary of Defense (OSD), and the various Armed Services to review the DOD acquisition process. He proposed to streamline the acquisition process to make it a more economical efficient system. After an extensive review, the working groups published their report recommending 31 initiatives to enhance the acquisition process. After reviewing the report, a 32nd initiative was added. A decision to make major changes in the acquisition process was made.

The 32 initiatives were aimed at significantly improving the DOD acquisition process by reducing cost, making the process more efficient, increasing program stability and decreasing the time it takes to acquire military hardware.
(9:39)

Carlucci's 32 initiatives were officially known as the DOD Acquisition Improvement Plan (AIP).

Initiative Five, "Encourage Capital Investment to Enhance Productivity," proposed to increase DOD contractor productivity by stimulating increased capital investment. One of the specific items recommended by initiative Five was the Industrial Modernization Incentives Program (IMIP).

In November 1982, a test of the IMIP was authorized. The test was based on the successful Air Force TECHMOD program and received support from all the services. Since

it was a multi-service program designed to modernize and improve the defense industrial base, it was titled "DOD Industrial Modernization Incentives Program" (14:23).

IMIP Definition. IMIP is a "joint venture between the government and industry to accelerate the implementation of modern equipment and management techniques in the industrial base" (1:1). For the purpose of this research, IMIP and TECHMOD are interchangeable.

All contractors, prime, subcontractors, and vendors are targets of potential productivity improvements. Further IMIP projects are not limited to major weapon systems (9:41). IMIP eligibility extends to any contractor performing work for an Air Force program.

There are four ways to initiate an IMIP:

1. It may be contained in a program's Request for Proposal (RFP).
2. It can be achieved through mutual Air Force/contractor agreement during performance of an Air Force contract.
3. It can be proposed by a contractor.
4. It can be initiated through a Source Sought Synopsis, RFP, or competitive process. (9:42)

IMIP Merits. Numerous articles and reports have been written on the merits of IMIP. Four of the most common merits of the program are potential savings, increased subcontractor potential, contracting incentives and increased productivity potential.

One of the short term efforts of IMIP is to reduce the cost of defense related items through productivity gains (1:1). According to the Air Force Systems Command Industrial Modernization Incentives Program Technical Review, "As a result of these IMIP investments, savings in excess of \$5 billion are expected over the next decade" (3:11). The validated savings thus far for the Air Force Aeronautical Systems Division is over one quarter of a billion dollars. Validated savings should increase dramatically, considering the current savings is provided by less than 10 percent of IMIP contractors (1:11).

Subcontractors play a vital role in our defense industry. An Aeronautical System Division estimate is that over 60 percent of the cost of major weapon systems is generated by subcontractors. With this rather large figure in mind, Aeronautical Systems Division has placed more emphasis in targeting most of the modernization function toward subcontractors (1:11).

Another Aeronautical Systems Division study showed the effect of funding of IMIP. The study showed that

1. Contractors with a high percentage of direct government business invested \$2 for each Air Force dollar.
2. Contractors with about 50 percent direct government business invested \$5 for each Air Force dollar.
3. Contractors with little direct government business invested \$7 for each Air Force dollar. (13:12).

These numbers indicated that additional interest among businesses that are not currently depending on the "military dollar" may be interested in defense-oriented business. If this is the case, additional sources for parts, supplies and services become available.

The IMIP provides incentives to reduce costs. Three important contracting incentives are:

1. Productivity Shared Savings Awards which permit industry to share in the Air Force's savings through the use of a sharing agreement on a percentage basis, through a return on investment approach, or through other appropriate approaches. The IMIP, therefore, removes any industry motivation to inflate cost in order to maintain or increase profits.
2. Contract Termination Protection through an unfunded, contingent liability guarantee to allow for Air Force compensation of the undepreciated balance of the capital assets in the event of premature termination.
3. Contractor Investment to include all assets and real property. Since the current policy in Defense Federal Acquisition Regulations paragraph 3-815 only allows investment protection on several assets, a blanket waiver was approved so that real property could be considered in the investment analysis. (9:43-44)

Numerous studies have shown that productivity is directly related to technology and capital. "Approximately 80 percent of the rate of productivity growth can be attributed to capital and technology" (9:29). If this percentage or ratio of productivity growth remains stable, IMIP programs will have a positive effect upon the productivity of the industrial base of our nation.

IMIP Problems. A recent U.S. General Accounting Office (GAO) report, DOD's Industrial Modernization Incentives Program: An Evolving Program Needing Policy and Management Improvement, highlighted

1. Potential IMIP benefits to the government are substantial, but visibility of and accountability for benefits need to be strengthened.
2. Although a steering group developed draft policy and guidance that adequately discusses some management issues, improved guidance should be developed through further analysis and testing of approaches.
3. Structured planning and programming systems need further development to help the services maximize program benefits. (13:2).

The GAO found that the DOD expected to save \$6 billion over the next ten years (see Appendix A). The problem is that these estimates may not be entirely accurate. The GAO found the early projected savings estimate decreases significantly as the projects move into Phase III of the program. Further, the GAO found that the Office of the Secretary of Defense (OSD) and the different armed services have not developed guidance on how to input IMIP benefits into weapons system budgets (13:4-8).

Further, the GAO found that the DOD steering group, established in 1982, did not develop a plan for significant issues such as "1) the effects of, or need for funding, and 2) the differences in IMIP efforts with prime contractors versus subcontractors" (13:28). The GAO concluded that a

planning and programming process would help decide how IMIP funds should be allocated and how to best track contractor performance. The GAO acknowledged that the Air Force was progressing well in this area but indicated further work is needed (13:28).

The GAO report solidifies the findings of Cooper and Houck that, prior to their research, there was no consensus among the experts on how to comprehensively evaluate IMIP (9:46).

IMIP Effectiveness Criteria. The lack of standardized IMIP evaluation criteria is what led Cooper and Houck in their thesis effort, Measuring the Effectiveness of the Industrial Modernization Incentives Program. Their research indicated that most IMIP managers and contractors believed the IMIP was reducing weapon systems acquisition cost and leadtimes and improving the strength of the defense industrial base. Their goal was to develop a consensus of opinion on what criteria could be used to evaluate the effectiveness of the IMIP (9:48).

Through a series of interviews with government and contractor personnel associated with the IMIP they identified nine out of seventeen possible criteria as valid measures of the effectiveness of the IMIP (9:105). The nine criteria are:

1. reduced acquisition cost
2. improved productivity
3. improved item quality
4. advances in state-of-the-art technology
5. degree of technology transfer
6. increased surge/mobilization capability
7. reduction of production leadtime
8. plant modernization
9. reduced critical material usage

The eight criteria that were found to be "of marginal value" (9:106) are:

1. percentage of IMIP projects directly applied to DOD weapon system production
2. percent of projects completed
3. degree of improved readiness
4. improved reliability
5. increased competitiveness
6. number of commercial spinoffs
7. ability to increase productivity growth rate
8. follow-on contracts

Their effort concluded the first stage of research in developing an effective measure instrument for the IMIP.

The objective of this second stage of research is to apply those nine criteria found to be valid measures of effectiveness to selected IMIP projects. The following chapter, Research Methodology, provides the research guidelines used in this second stage effort.

III. Methodology

Introduction

The U.S. defense industrial industries have been reluctant to modernize their plants with new technology. Department of Defense (DOD) Industrial Modernization Incentive Program (IMIP) and the Air Force Technology Modernization (TECHMOD) program were developed to encourage defense contractors with contractual and shared savings incentives to modernize industrial facilities. This modernization attempts to reduce major weapons systems cost and to strengthen the defense industrial base.

Since implementation of the modernization program, an instrument to evaluate the effect of IMIP has not been developed. In a 1985 Air Force Institute of Technology thesis, Measuring the Effectiveness of the Industrial Modernization Incentives Program, Cooper and Houck identified nine evaluation categories that were found to be valid criteria to evaluate the program. These criteria must be applied to IMIP projects to measure the effect IMIP is having upon weapon systems cost and the defense industrial base. Their thesis marked the end of the first of two stages in this research effort.

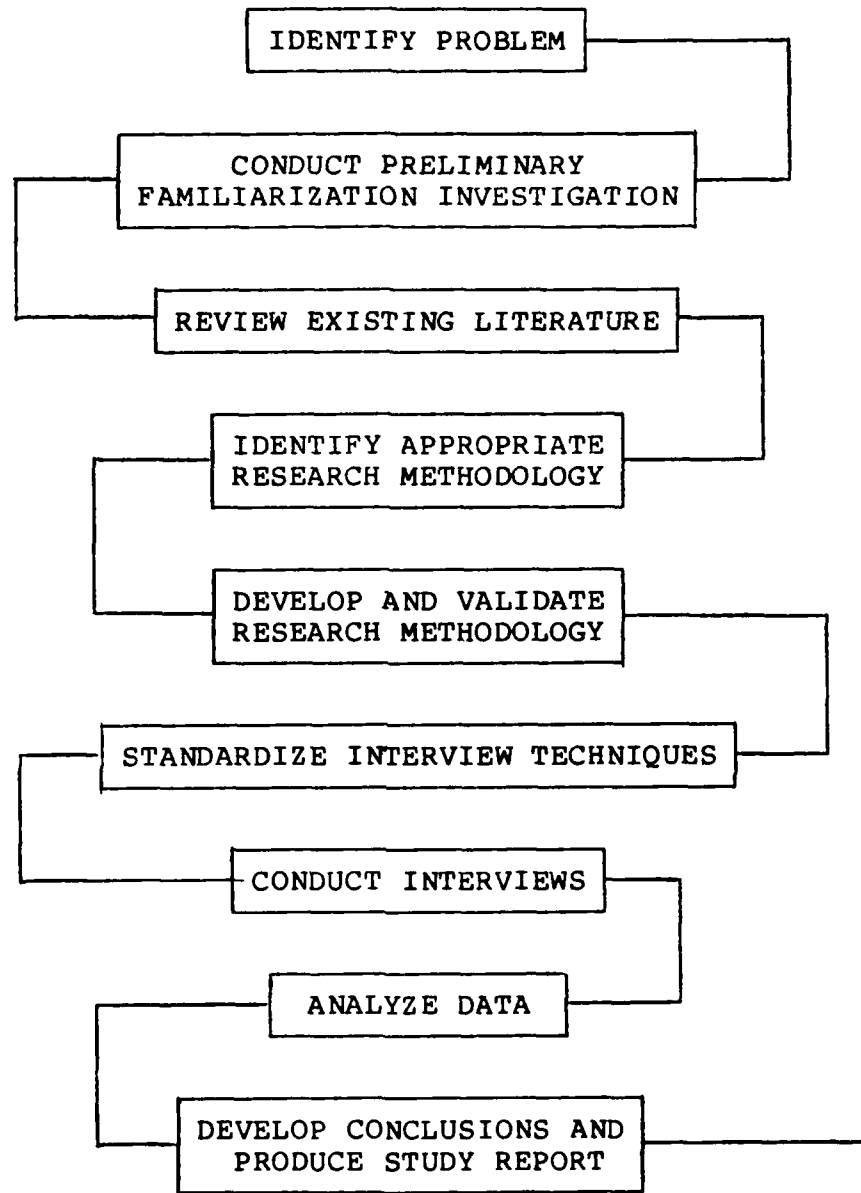
The goal of this second stage is to apply the nine criteria Cooper and Houck validated as effective measures of the IMIP to selected IMIP projects. This chapter out-

lines how the nine criteria were applied through a series of telephone and personal interviews with defense contractor IMIP program managers. Figure 4 describes the general research methodology used in both stages of this project.

Methodology Justification

The selection of telephone and personal interviews instead of a mail survey questionnaire for the data collection technique stemmed from the first stage of research. Cooper and Houck found that "the use of personal and telephone interviews would enhance the probability of collecting clear, accurate responses" (9:50). While Cooper and Houck used both personal interviews and telephone interviews, during this second stage of research personal interviews were used only if a contractor IMIP manager was available to be interviewed at Wright-Patterson AFB, Ohio. The lack of travel funds combined with the amount of time required to do additional personal interviews were prohibitive. Further, the ability to control interview bias was equally attractive for telephone interviews as compared to personal interviews. As C. William Emory, in Business Research Methods, states, "results of personal interviews can be affected adversely by interviewers who alter the questions asked, or in other ways, bias the results" (11:161). Additionally, this second stage of research is based on contractor data which was limited from local sources.

STAGE I



STAGE II



Figure 4. Research Methodology (9:49)

Telephone interviews have some inherent limitations that may induce bias and negatively effect the validity of research. Emory points out that "the first limitation is that the respondent must be available by phone" (11:170). The second disadvantage to telephone interviews is the limit on the length of the interview. Emory states,

Ten minutes or so has generally been thought of as the maximum, but interviews of 20 minutes or more are not uncommon. Interviews ran as long as 1.5 hours. (11:171)

The third major disadvantage to telephone interviews is the availability of "budgets, maps, illustrations or complex scales" (11:171). The lack of visual aids limits the complexity of the questioning.

Interview Schedule Design

The interview schedule (see appendix B) was designed to accommodate the telephone/personal interview technique selected for this research study. The interview technique limited the length of the interview and the availability of support material. The intent of the interview schedule was to provide a format to complete the interview in approximately thirty minutes.

The nine IMIP effectiveness measures were drawn from the stage one research by Cooper and Houck. Each of the nine criteria were listed and applied to the selected IMIP projects. The following investigative questions provided the basis for the interview.

1. Has IMIP reduced acquisition cost?
2. Has IMIP improved productivity?
3. Has IMIP improved item quality?
4. Has IMIP improved state-of-the-art technology?
5. Has IMIP increased the degree of technology transfer?
6. Has IMIP increased surge/mobilization capability?
7. Has IMIP reduced production lead times?
8. Has IMIP increased plant modernization?
9. Has IMIP reduced critical material usage?

Each investigative question was followed by specific questions that would provide both quantitative and qualitative support to answer the investigative questions. Further, the interview participants were asked whether they believed the IMIP effectiveness measure was a valid criterion for measuring the effectiveness of IMIP. This question was designed to confirm the validity of the nine criteria identified by Cooper and Houck. Once the prepared interview schedule was completed, it was submitted to the Aerospace Industrial Modernization (AIM) office, AFSC/PMI, for a final review prior to application.

Respondent Selection

IMIP contractors were selected for the interview from a list of fourteen possible candidate companies provided to the author by the AIM office. Ten companies were randomly chosen using the random sampling procedures described by

McClave and Benson in Statistics for Business and Economics (18:141). Due to conflicting schedules, only eight of the ten IMIP contractors were interviewed. A listing of respondents is provided in Appendix C.

Interview Technique

Telephone and personal interviewing for research investigation is more difficult than just asking a person a simple question. As Emory states, "What we do or say as interviewers can make or break a study" (11:162). Interviewers must develop a good interviewing relationship with the respondent to ensure the research data is meaningful. Emory illustrates that

The respondent must 1) feel that the experience will be pleasant and satisfying; 2) believe that the survey is important and worthwhile; and 3) have any mental reservations satisfied. (11:162)

To establish the rapport and legitimacy of the research with the respondents the following guidelines were followed.

1. Each prospective respondent was initially contacted by telephone to ensure willingness to cooperate in the study.
2. A letter of introduction, along with key terms and definitions, were forwarded to the prospective respondent at least two weeks prior to the proposed interview date.

3. Each prospective respondent was again contacted approximately three days prior to the interview date. The interview data and time were confirmed and the prospective respondent was given the opportunity to ask any questions concerning the interview.

4. The respondents were guaranteed anonymity of their responses and an explanation of how that data analysis would be presented in the study.

5. The respondents were provided an opportunity to add personal opinions or observations after each investigative question and supporting questions was answered.

6. The interviewer recorded the respondent's answers using the predetermined interview schedule (see Appendix B).

Limitations

This research was limited to a specific population of IMIP projects that personnel from the AIM office identified as possible candidates for the interview. The maturity of the IMIP program did not lend itself to independent, random sampling of the entire IMIP population. As more companies move into the Phase I and Phase II segments of IMIP, more data will become available that will allow random sampling.

The data gathered from the interviews was provided by contractor personnel and was not verified with Air Force representatives for completeness. Estimated data was used to draw inferences on the investigative questions when "hard" data was either not available at this stage of the

IMIP project or unobtainable due to different information management system tracking techniques of the different contractors. The interviews were based on the entire contractor IMIP program when data was available rather than on a specific IMIP effort at a certain phase in the program.

IV. Findings and Analysis

Introduction

A total of eight interviews were conducted during the period from 20 June 1986 to 15 August 1986. Ten Industrial Modernization Incentives Program (IMIP) contractor programs were originally selected for this stage of the research. However, due to scheduling conflicts, two of the IMIP program managers could not be contacted for the interview. Each of the eight individuals interviewed were extremely helpful and sincerely interested in supporting this research. The duration of the interviews ranged from approximately 30 to 50 minutes.

The analysis of responses to the nine investigative questions is summarized in this chapter. Additionally, each criterion was analyzed to reconfirm its validity. Further, the respondent's comments are provided for each criterion.

Reduced Acquisition Cost

Seven of the eight respondents reported that IMIP did, indeed, reduce acquisition cost. An analysis of the respondent's answers revealed that every dollar invested in an IMIP project resulted in a three dollar savings. This savings by itself may not directly reduce acquisition cost, but it is an indication of the return on investment (ROI) that is possible with IMIP.

Each respondent was asked if "reduced acquisition cost" was a valid criterion for evaluating IMIP. All eight respondents concurred that reduced acquisition cost was a valid measure. Four respondents caveated their concurrence of this criterion. Three believed that "shared acquisition cost savings" would be a better criterion than just reduced acquisition cost. Further, another respondent indicated that the "long term reduction in acquisition cost" should be the goal, rather than a "quick payoff."

Improved Productivity

One hundred percent of the respondents indicated that IMIP improved productivity. Five of the respondents had productivity increases between 10 percent and 100 percent for certain specific processes or functions. The other three respondents believed that productivity had increased, but were unable to quantify the increase at that time. Each respondent was quick to point out that the increase in productivity was for only a certain process or function. The productivity increase is relatively small when compared to the total system that the function or process supports.

Five of the respondents indicated that "improved productivity" was a valid criterion for evaluating IMIP. Three respondents believed that the IMIP projects were minute when compared to the overall system. Further, one of these respondents indicated there would be an increase in overhead due to antiquated cost savings accounting if

IMIP deals only with hands-on labor. Additionally, one respondent who concurred that improved productivity was a valid criterion noted that "improved productivity" and "reduced acquisition cost" were possibly redundant criteria.

Improved Item Quality

One hundred percent of the respondents concurred that IMIP improved item quality. However, they all believed that this criterion was difficult to measure. Only two respondents were able to quantify quality improvements. A 10 percent decrease in inspection cost of two specific processes were realized. Additionally, one respondent had a 20 percent decrease in the rework level associated with one of these processes.

All eight of the respondents agreed that "improved item quality" was a valid criteria for evaluating IMIP. comments on this criteria indicate that reduction of rework levels and decreased inspection cost were areas in which limited savings could take place on discrete projects.

Advanced State-of-the-Art Technology

Five of the eight respondents indicated that IMIP had advanced the state-of-the-art technology. Advances in technology ranged from improved visual inspection techniques, to automation, to the development of advanced machinery for complex engine rotor blades. Three respondents indicated IMIP had not increased advances in

technology. All three stated advances in technology were internally funded separate from IMIP projects.

Five of the eight respondents believed "advanced state-of-the-art technology" was a valid criterion for evaluating IMIP. Three respondents did not concur. Two respondents thought the criterion was too broad and would be difficult to quantify. Additionally, one respondent pointed out that the Air Force Manufacturing Technology (MANTECH) program was designed to encourage technology modernization - not IMIP.

Technology Transfer

One hundred percent of the respondents indicated that IMIP increased the transfer of technology, although two of the respondents indicated that the degree of technology transfer did not directly pertain to their projects. Four respondents indicated that the degree of technology transfer did not directly pertain to their projects. Four respondents indicated their company was the originating company of the technology that was transferred. Only one company indicated that they were the recipient of IMIP-generated technology. All of the respondents indicated that IMIP encouraged the transfer of technology. One of the most effective methods mentioned was the Annual IMIP Conference sponsored by the Aerospace Industrial Modernization (AIM) office located at Air Force Systems Command (AFSC)/PLI, Wright-Patterson Air Force Base, Ohio.

Additional methods of disseminating information were final reports generated on DOD projects, the Defense Technical Information Center (DTIC), factory tours and general marketing information.

The six respondents who indicated their company was the originating company were asked, "How many companies were influenced to adapt IMIP-generated technology with internal funding?" Two respondents stated that tracking the number of other companies adapting IMIP-generating technology was, at best, a difficult task. Cost savings as a result of technology transfer could not be analyzed due to the lack of data.

Six respondents believed that the criterion "degree of technology transfer" was valid for evaluating IMIP. Two respondents did not believe the criterion was valid primarily because it would be too difficult to quantify. As previously stated, all respondents believed this criterion would be "difficult" to "impossible" to quantify.

Surge/Mobilization Capability

Fifty percent of the respondents indicated that IMIP had increased their surge/mobilization capability. The responses were qualified, in that the increased capability was only for a certain process for function. This increased capability had minimal effect on overall production capability of an end item or weapon system.

The four respondents who stated that IMIP had not increased their surge/mobilization capability held similar views on IMIP projects. They believed that IMIP related projects were but one of numerous functions or processes in their overall production phase. The increased capability provided by IMIP projects was negligible as far as production of an end item was concerned. Additionally, two of the four noted that their companies already had surge/mobilization plans and that the IMIP projects did not alter them.

The use of "increased surge/mobilization capability" as a criterion for evaluating IMIP resulted in a fifty-fifty split. Four of the respondents believed that it was a useful tool on a micro level but not on a macro approach. The four that did not believe the criterion was valid indicated that the criterion was valid indicated that the criterion was not useful for measuring the end item or weapon system production capability. Thus, its usefulness was limited at best.

Reduced Production Leadtime

Three respondents indicated that IMIP projects reduced production leadtime. One project reduced the leadtime of a certain process by five days. A leadtime reduction of 40 percent was realized on a different project. The third respondent stated that the reduced leadtime was yet to be determined.

Five respondents stated that production leadtime had not been reduced as a result of IMIP. The consensus of opinion was that IMIP projects were only a small part of a large process. The leadtime reduction, if any, was insignificant to the entire system.

The question of "production leadtime" as a criterion for evaluating IMIP drew four positive and four negative responses. The four who supported production leadtime as a valid criterion generally believed that the major impact in this area would be felt at the subcontractor area. Another comment indicated that anything that shortens the production cycle saves time - and time is money. The four individuals who did not believe "production leadtime" was a valid criterion essentially believed that the criterion was too difficult to measure at the end item level. Two of the four acknowledged that on "discrete" projects at the subcontractor level this criterion "might" be valid in evaluating IMIP.

Plant Modernization

Five respondents stated that IMIP increased plant modernization. Three of the five individuals provided specific examples of plant modernizations. One manager estimated that the average age of capital equipment was reduced by five years and that capital funds expenditure had increased by 25 percent. Another respondent noted that capital funds expenditure increased by \$4 million over a

three-year period as a result of IMIP. The third example was the development of a process requiring the purchase of a new piece of machinery for one IMIP project. The remaining two respondents noted that new equipment was obtained as a result of IMIP, but its overall effect was minimal.

The respondents split fifty-fifty on the issue of "plant modernization" as a valid criterion for evaluating IMIP. The four managers who supported this criterion expressed the general belief that plant modernization was a very positive result of IMIP. One individual stated that IMIP was "a major breakthrough for the DOD-contractor relationship" for the modernization of the defense industrial base. Additionally, a non-supporter of this criterion indicated that IMIP provided an avenue to acquire corporate support for "high risk" areas with longer payback periods since the DOD would help offset a portion of the risk.

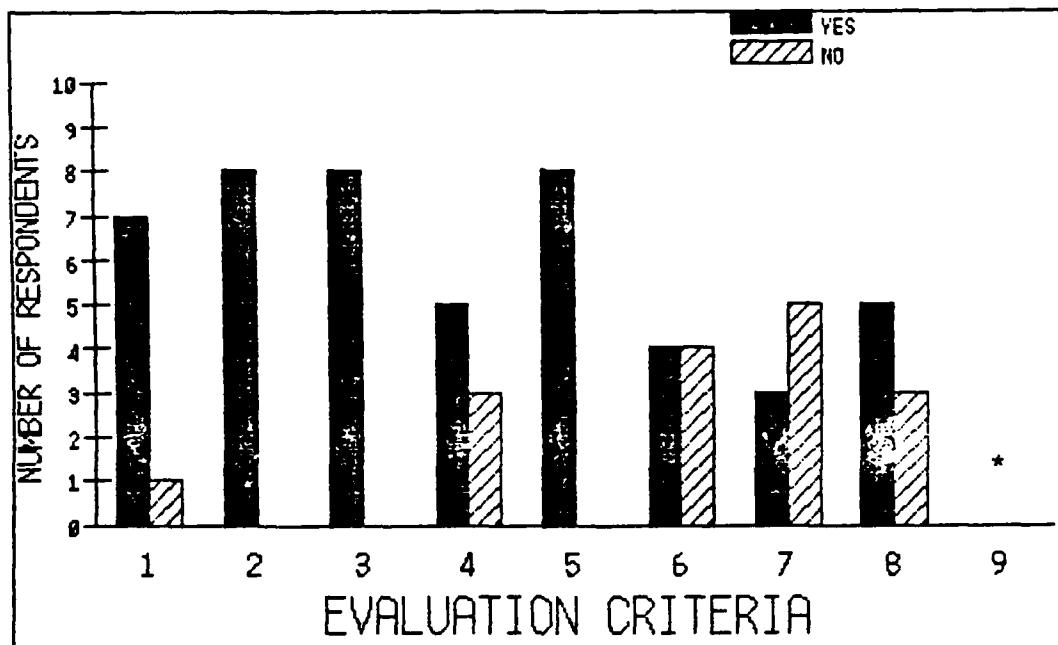
The four respondents who do not believe plant modernization is a valid criterion generally had active modernization plans already in place. The IMIP projects made up a small portion of their overall effort. One individual pointed out that if this criterion was used, companies that were aggressively modernizing on their own would not look as good as companies that were relying on IMIP to modernize. Further, another individual noted that software development was also important, while not typically being recognized as a "capital expenditure."

Critical Materials Usage

None of the respondents indicated that their IMIP projects were intended to reduce critical materials usage. Further, they split fifty-fifty on whether "critical materials usage" was a valid criterion. All agreed that this criterion was project specific and if critical material usage was reduced as a result of IMIP, and that the reduced usage was an objective of that IMIP project, then the criterion would be useful.

Summary

The results of the interview are summarized in Figures 5 and 6. One criteria, "reduced critical materials usage," could not be evaluated, but its relative merit is discussed. A weighted scale was devised using the criteria validation data (see Figure 1). Each "yes" answer was assigned a value of one. Thus, reduced acquisition cost received a value of eight. The values of all the criteria were then added together. This sum total was then divided into the value associated with each criteria. This mechanism provided the weight for each criterion. While the sixth, seventh, eighth and ninth criteria were assigned the same weight, there was no evident correlations between the IMIP projects or respondents. This basic analysis provides the groundwork for the conclusions and recommendations provided in Chapter V. Further specific ideas for additional research are included.

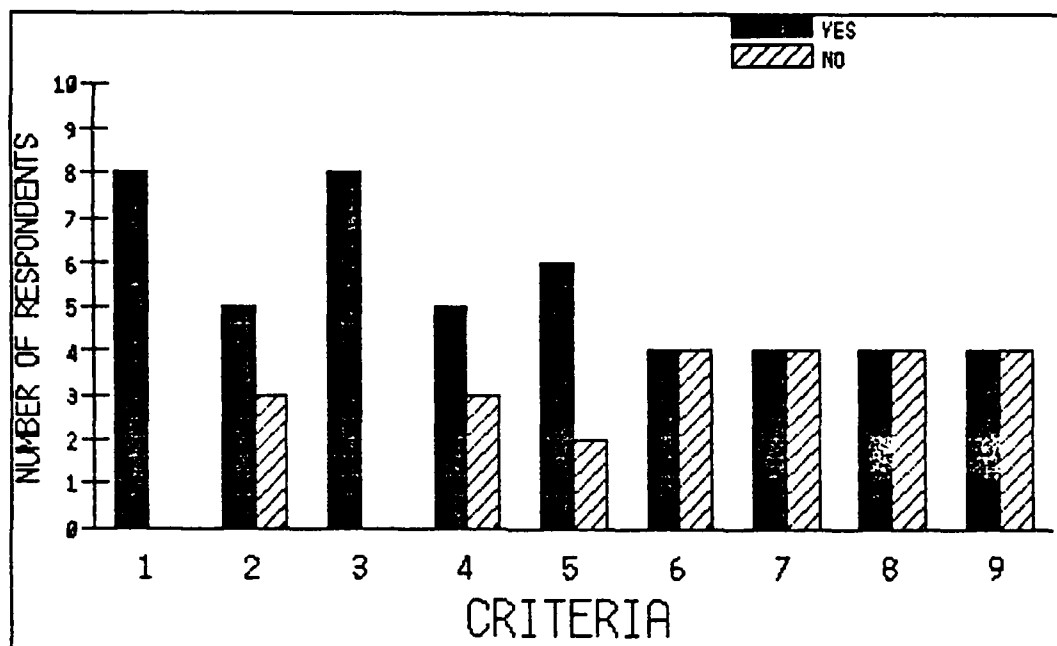


* Critical materials usage could not be evaluated

Interview Questions

1. Has IMIP reduced acquisition cost?
2. Has IMIP improved productivity?
3. Has IMIP improved item quality?
4. Has IMIP advanced state-of-the-art technology?
5. Has IMIP increased the degree of technology transfer?
6. Has IMIP increased surge/mobilization capability?
7. Has IMIP reduced production leadtime?
8. Has IMIP increased plant modernization?
9. Has IMIP reduced critical materials usage?

Figure 5. Evaluation of IMIP



List of Criteria

Weights

1. Reduced Acquisition Cost	.166
2. Improved Productivity	.104
3. Improved Item Quality	.166
4. Advanced State-of-the-Art	.104
5. Technology Transfer	.125
6. Surge/Mobilization Capability	.083
7. Reduced Production Leadtime	.083
8. Plant Modernization	.083
9. Critical Materials Usage	.083

Figure 6. Criteria Validation

V. Conclusions and Recommendations

Introduction

The Industrial Modernization Incentives Program (IMIP) is the first significant DOD attempt to provide a catalyst for defense contractors to modernize the defense industrial base. IMIP evolved from the Air Force Technology Modernization (TECHMOD) program that was designed to reduce weapon systems cost and strengthen the industrial base. While IMIP has continued to mature since its 1982 beginnings, criteria for evaluating its effectiveness have been lacking.

This second stage of research is built upon the study completed by Cooper and Houck, Measuring the Effectiveness of the Industrial Modernization Incentives Program. Cooper and Houck identified nine criteria that were validated as useful tools in evaluating the effectiveness of IMIP (9:105). During the second stage, these criteria were applied to selected IMIP projects to see if IMIP reduces weapon systems cost and modernizes the U.S. defense industrial base. To answer this question the nine criteria were rephrased into nine investigative questions. These investigative questions formed the foundation for the eight personal/telephone interviews with defense IMIP contractors conducted for this study. The investigative questions

will be discussed and conclusions drawn in this chapter. Additionally, recommendations are made for further study.

Investigative Question 1

Has IMIP reduced acquisition cost?

IMIP is reducing acquisition cost. As more projects move into the third phase of IMIP, identifying actual cost reductions will be easier to identify. This study found that for every dollar invested by both the contractor and the Air Force, a potential three dollar return is achievable. Not all projects will give this return on investment (ROI) and some projects may provide a better ROI. The underlying point is that IMIP can reduce weapon systems acquisition cost, but the time required to achieve the reduction will vary.

The effect an IMIP has on reduced acquisition cost should be analyzed for IMIP projects. One contractor stated that reduced acquisition cost is the criterion on an IMIP project. Additionally, a shared savings formula is needed for each program to continue contractor support of IMIP.

Investigative Question 2

Has IMIP increased productivity?

IMIP has increased productivity. Productivity increases will vary depending on what the overall goal of each IMIP project is. At the micro level productivity

increases may be more apparent than at the macro level. A certain process may have a 50 percent productivity gain, yet the end item or weapon system may feel no effect from this gain.

Cooper and Houck suggested linking this productivity gain to decreased total system cost (9:112). The development of a procedure or formula was beyond the scope of this research effort. Additionally, this author is unsure if an increased tracking mechanism would be cost effective and provide any pertinent data for IMIP justification or evaluation.

Improved productivity should be used to evaluate IMIP projects. As with all IMIP evaluation criteria, clear goals should be stated between participants at the onset of the project to prevent any misinterpretation of objectives.

Investigative Question 3

Has IMIP improved as a result of IMIP?

Item quality has improved as a result of IMIP. This statement must be caveated in that the individual processes associated with IMIP seem to be producing better items, but these processes are but one of many needed to produce an end item or weapon system. To correlate increases in the quality a specific item with increased weapon system quality serves no purpose except to add additional tracking and administrative burdens to both contractor and DOD program managers. If IMIP projects produce a higher quality

product, that in itself should be sufficient. As time passes and additional data is available, failure rate data might be used to quantify item quality, but once again the increased administrative cost might outweigh the analysis gains.

Improved item quality should be used to evaluate IMIP projects. Not all projects may lend themselves to measuring the scrap and rework levels or reduced inspection cost. Additionally, the item quality may be extremely high to start with, so a ratio or percentage increase comparison would be unfair. On a weighted scale, this criteria should receive equal or less weight than reduced acquisition cost.

Investigative Question 4

Has IMIP advanced state-of-the-art technology?

IMIP has advanced the state-of-the-art technology in certain specific processes. However, the Air Force Manufacturing Technology (MANTECH) program seems to be more oriented to advancing state-of-the-art technology than IMIP. Advancing technology under IMIP may not be as important as encouraging contractors to apply current technology to manufacturing processes. As more up-to-date processes are institutionalized in the defense industrial base, advanced technology may become a more important factor for consideration.

Cooper and Houck stated advances in the state-of-the-art "should be quantified by itemizing advances in the

state-of-the-art resulting from an IMIP project and linking these advances to any resulting cost reduction" (9:109). The listing of advances in technology poses no particular problem, but a system for linking these advances to a cost reduction is not available and is possibly not worth the cost of developing.

Advances in state-of-the-art technology should be applied to IMIP projects. While this criterion should be used, it may not be applicable to all IMIP projects. Additionally, its weight on a weighted scale may be on the low side.

Investigative Questions 5

Has IMIP increased the degree of technology transfer?

Increased technology transfer has resulted from IMIP. New "doors" have been opened in which contractor-to-contractor and contractor-to-DOD crosstalk has increased. This crossflow of information helps to foster not only technology transfer, but the transfer of management ideas and approaches to achieve a better product for the customer. Meetings, seminars, publications and conferences have all helped the flow of information on current and developing technology.

The ability to quantify, track and analyze the impact IMIP is having on technology transfer is a difficult task. A system of monitoring an IMIP project at both an originating company and a recipient company is not available and,

as with any administrative detail, would add overhead, thus cost, to a project.

The degree of technology transfer should be applied to IMIP projects. As with a number of the criteria, it may or may not apply directly to all projects. The important aspect is that if the technology would benefit like programs, then it should be publicized to help ensure that crossfeed of information is taking place. Care should be taken not to weigh this criterion too heavily, as it seems to be a by-product rather than an objective of IMIP.

Investigative Question 6

Has IMIP increased the surge/mobilization capability?

Results of this study indicate that the surge/mobilization capability has increased as a result of IMIP. This statement requires qualification in that the surge/mobilization capability increase is seen primarily at the micro level, not at the end item or weapon system level. Subcontractors and suppliers would feel more of an increase in capability to respond to an increased tasking. As more subcontractors develop IMIP projects, the defense industrial base may be able to respond more rapidly, but the prime contractors are limited because the end item requires a certain percentage of parts and equipment from subcontractors or suppliers.

A simple increase in the production ratio of a certain IMIP project may have little impact on an end item. The

increased ratio may be important but a systems view of its effect is required.

Increased surge/mobilization capability is a valid criterion for IMIP projects. Yet, it must be used only as an indication of what that specific process or function is capable of producing. A company may be able to quadruple its production ratio of a certain item, but if only half of those items can be used in an end item production scenario, its high production ratio is not valid for evaluation purposes. Once again, this criterion should be weighted and viewed from a systems approach for evaluation purposes

Investigative Question 7

Has IMIP reduced production leadtime?

The effect IMIP has had on production leadtime is minimal when the systems approach is applied. On specific processes and functions production-leadtime has been reduced, which shortens the overall manufacturing/production cycle. This reduction would be more significant at the subcontractor level than at the prime contractor level.

The reduced production leadtime may be calculated by subtracting the production leadtime after IMIP implementation, from production leadtime before IMIP, to obtain its overall impact on that process. This research discovered that it was difficult to apply this quantifiable figure to finished products, raw material or work in process inventory cost, as Cooper and Houck suggested (9:111).

Reduced production leadtime should be used to evaluate IMIP projects only at the subcontractor level. The criterion appears to be difficult to measure at the weapon system or end item level and may be just as difficult to evaluate at the subcontractor level depending on the IMIP project. Unless a formula for each project is developed to measure the effort reduced production leadtime is having upon the cost of the finished good, the usefulness of this criterion is questionable.

Investigative Question 8

Has IMIP increased plant modernization?

IMIP is providing a catalyst for plant modernization. The "top down" factory analysis that is the basis for all IMIP projects provides the methodology and framework for contractor self-analysis. This process may provide as much positive fallout as it does for identifying specific IMIP projects. IMIP has spawned a healthy modernization attitude that may flow into the contractors' own internal modernization program. While most contractors already have some sort of ongoing modernization programs, IMIP has provided an additional impetus on this never ending task.

IMIP evaluators should be flexible when applying this criterion to IMIP projects. Numerous factors such as "increased capacity, production through-put, decreased rejection, scrap and rework rates" (9:112) are all variables that could be used to define this criteria. This

study used the average age of capital equipment before and after IMIP implementation and increased capital funds expenditures as a result of IMIP implementation for its basis. While they are indicators of modernization, other areas such as software development proved hard to quantify within the more stringent guidelines.

Increased plant modernization should be used to evaluate IMIP projects, although its weight should be on the low side of the scale. Modern aggressive companies may have overall plans to continue modernizing their company. A single IMIP project might have little impact on their average age of capital equipment or increased capital expenditures. As with the other criteria, each project will have to be measured on its own merit.

Investigative Question 9

Has IMIP reduced critical materials usage?

This research effort did not include any IMIP projects that were designed to reduce critical materials usage. Thus, the investigative question remains unanswered.

If one of the objectives of an IMIP project is to reduce critical materials usage, then reduced critical materials usage is a valid criterion for measuring the effectiveness of that project.

Conclusions

IMIP has reduced the weapon systems cost and provided a catalyst for the modernization of the U.S. defense industrial base. The impact IMIP is having is difficult to measure due to the relatively few projects that are in the implementation phase, Phase III. As more projects move into this third phase, better cost analysis data will become available.

The nine criteria that were used in this study show promise as evaluation criteria. The nine should form a list of possible criteria that may be used to evaluate the effectiveness of IMIP, although not all nine may apply to each project. Results indicate that reduced acquisition cost and item quality should be used to evaluate all IMIP projects. The other criteria should be considered for each IMIP project and applied depending upon the goal of the project. Additionally, they will carry different weights depending upon the objective of the IMIP project in question. They do, however, provide a foundation or basis for an evaluation program.

Government IMIP managers and policymakers will have to be sensitive of both too much and too little evaluation depth. Too little depth may fall prey to heavy criticism and budget cuts. Too much and the administrative tracking burden may drive contractors away from the program.

As one of the interview participants stated, "IMIP is a healthy initiative designed to build cooperation between the DOD and commercial enterprise with a common goal between the customer and supplier - to make the product better."

Recommendations

Competition. The effect IMIP is having on free and open competition was beyond the scope of this research effort. More research is needed to identify the impact, either positive or negative, IMIP is having upon competition. The additional research should review both prime and subcontractor issues in the competition arena.

In-depth Analysis. This research and the first stage of the research were conducted through a macro approach attempt to evaluate the effectiveness of IMIP. The complexity of issues such as, "What is productivity? or "How do you actually measure and track item quality?" pose special problems. It is the opinion of this author that each of the nine criteria could be a thesis topic unto itself. The specialization into each area would provide for a more thorough, in-depth analysis of each area that was not possible during this study. Additionally, the weighted scale should be applied to IMIP projects to test its validity.

Appendix A. IMIP Phases and Projected Cost Reductions

(In millions of dollars)				
	Phase I	Phase II	Phase III	Total
<u>Air Force</u>				
Efforts ¹	12	16	5	33
Cost Reductions ²	\$ 199	\$2,657	\$1,383	\$4,239
<u>Navy</u>				
Efforts	9	5	0	14
Cost Reductions ²	\$ 862	\$ 745	\$ 0	\$1,607
<u>Army</u>				
Efforts	3	0	0	3
Cost Reductions ²	\$ 831	\$ 0	\$ 0	\$ 831
<u>TOTAL</u>				
Efforts	24	21	5	50
Cost Reductions ²	\$1,892	\$3,402	\$1,383	\$6,677

(12:5)

¹Eight Air Force efforts in this chart include more than one contractor and/or subcontractors and vendors. All 77 contractors participating in Air Force efforts are included.

²Benefits for fifteen efforts had not been quantified at the time of this review. For the remainder, the consistency and bases for reporting benefits may vary substantially.

Appendix B. Interview Instrument

Interview Schedule

Interview Control Number _____

Date of Interview _____

Start Time _____ Stop Time _____

Background Information

Name _____

Firm _____

Job Title _____

IMIP Project _____

Interview Information

Investigative research of a 1985 Air Force Institute of Technology thesis team identified nine criteria that were found to be useful in evaluating the Industrial Modernization Incentives Program (IMIP). My objective is to apply these nine criteria, listed below, to selected IMIP projects. The application of these criteria to IMIP projects will measure the effectiveness of IMIP and determine the usefulness of the criteria themselves. Additionally, I would like your opinion on validity of each criterion used in the evaluation.

The following investigative questions provide the foundation for my analysis:

1. Has IMIP reduced acquisition cost?
2. Has IMIP improved productivity?
3. Has IMIP improved item quality?
4. Has IMIP advanced state-of-the-art technology?
5. Has IMIP increased the degree of technology transfer?
6. Has IMIP increased surge/mobilization capability?
7. Has IMIP reduced production lead times?
8. Has IMIP increased plant modernization?
9. Has IMIP reduced critical material usage?

All nine of these criteria may or may not apply to a specific IMIP project. Additionally, the associated questions for each criterion were derived from the guidelines proposed in the initial thesis research.

If your company has more than one on-going IMIP effort, the interview question will be directed to the most mature IMIP project.

Interview Questions

- (1) Has IMIP reduced acquisition cost?
 - a. Yes (Go to 1a)
 - b. No (Go to 1b)
- (1a) What is the present total (indirect and direct) cost savings figure?
- (1b) What was the cost of the IMIP project?
- (1c) What was/is the estimated total cost savings figure?
- (1d) In your opinion, is this a valid criterion to be used in evaluating IMIP?
- (2) Has IMIP improved productivity?
 - a. Yes
 - b. No

By what percentage?
- (2b) Has this increase/decrease in productivity increased or decreased total system cost?

What is the percentage increase or decrease relative to total system cost?
- (2c) In your opinion, is this a valid criterion in evaluating IMIP?
- (3) Has IMIP improved item quality?
 - a. Yes
 - b. No
- (3a) By what percentage have scrap and rework levels increased or decreased as a result of IMIP implementation

- (3b) By what percentage have inspection cost increased or decreased as a result of IMIP implementation?
- (3c) In your opinion is this a valid criterion in evaluating IMIP?
- (4) Has IMIP advanced state-of-the-art technology?
- a. Yes
 - b. No
- (4a) What state-of-the-art advances resulted from this IMIP project?
- (4b) What state-of-the-art advances resulted in a cost reduction?
- How much was the cost reduction?
- (4c) In your opinion, is this a valid criterion for evaluating IMIP?
- (5) Does this IMIP project lend itself to the transfer of technology?
- a. Yes (Go to 5a)
 - b. No (Go to 6)
- (5c) How has this company encouraged the transfer of technology - meetings, seminars, publications, etc?
- (5d) How many companies were influenced to adapt IMIP-generating technology with internal funding?
- (5e) As a recipient company, how many DOD programs have been affected by the transfer of IMIP-generated technology?
- (5f) What is the cost savings realized as a result of technology transfer?

- (5g) In your opinion, is this a valid criterion in evaluating IMIP?
- (6) Has IMIP increased the surge/mobilization capability of your company?
- a. Yes
b. No (Go to 7)
- (6a) What was the production capacity before and after implementation of the IMIP project for normal, surge, and mobilization scenarios?
- | | Before | After |
|--------------|--------|-------|
| Normal | _____ | _____ |
| Surge | _____ | _____ |
| Mobilization | _____ | _____ |
- (6b) In your opinion, is this a valid criterion for evaluating IMIP?
- (7) Has IMIP reduced production leadtime?
- a. Yes
b. No (Go to 8)
- (7a) Production leadtime before IMIP minus production leadtime after IMIP implementation equals _____ days?
- (8) Has IMIP increased plant modernization?
- a. Yes
b. No (Go to 9)
- (8a) What was the average age of capital equipment before IMIP implementation? _____
- After implementation? _____

- (8b) How much did capital funds expenditure per fiscal period increase as a result of IMIP implementation?
- (8c) In your opinion, is this a valid criterion for evaluating IMIP?
- a. Yes
 - b. No (Go to 9d)
- (9a) What critical material(s) was this IMIP project intended to reduce consumption?
- (9b) What was the critical material quantity used before and after IMIP implementation?
- (9c) What is the cost reduction obtained through reduced critical material usage?
- (9d) In your opinion, is this a valid criterion for evaluating IMIP?

Appendix C. Interview Participants

1. Arvine, William, Production Staff. Telephone interview. Rockwell International Autonetics Strategic Systems Division, Anaheim, California 92803.
2. Bartlett, William. Telephone interview. General Electric Company, Syracuse, New York 13221.
3. Carlberg, Douglas, Manager, Industrial Modernization Incentives Program. Personal interview. Hughes Aircraft Company, Tuscon, Arizona 85734.
4. Dramon, Rex. IMIP Contractor Program Manager, Advanced Manufacturing Technology. Telephone interview. Eaton Corporation, AIL Division, Deer Park, Long Island, New York 11729.
5. McCaffrey, Lloyd. IMIP Contractor Program Manager. Telephone interview. William International Corporation, Walled Lake, Michigan 48068.
6. Reid, Leigh, Staff Technology Modernization Financial Management, General Dynamics Fort Worth Division. Telephone interview. General Dynamics, Fort Worth, Texas 76101.
7. Trexler, Bud, Director of Operations LANTIRN. Telephone interview. Martin Marietta Orlando Aerospace, Orlando, Florida 32855.
8. Tulkoff, Joseph, Director of Manufacturing Technology, Lockheed Georgia Air Force Plant No. 6 (GELAC). Telephone interview. Lockheed Georgia Corporation, Marietta, Georgia 30063.

Appendix D. Interview Introductory Correspondence



DEPARTMENT OF THE AIR FORCE
AIR UNIVERSITY
AIR FORCE INSTITUTE OF TECHNOLOGY
WRIGHT-PATTERSON AIR FORCE BASE OH 45433-6583

REPLY TO
ATTN OF: LSG

SUBJECT: Interview - Industrial Modernization Incentives Program

TO:

1. Thank you for agreeing to participate in my research effort in evaluating the effectiveness of the Industrial Modernization Incentives Program (IMIP). As we previously discussed, the purpose of this interview is to gather data on selected IMIP projects. Nine criteria will be used to evaluate the effectiveness of IMIP.
2. As a reminder, the telephone interview has been scheduled for _____ on _____ 1986.
3. I am a candidate for the degree of Master of Science in Logistics Management at the School of Systems and Logistics. My research is being sponsored by Dr William C. Pursch, Head, Department of Contracting Management.
4. A list of key terms, interview guidelines and definitions is attached. I believe it describes the scope and content of the interview. Please have this list available during the interview.
5. Again, thank you for your cooperation. If you have any further questions, please contact me at Area Code 513-255-5435/4437 (commercial) or 782-5435/4437 (AUTOVON).

DAVID E. SPENNY, Capt, USAF

1 Atch
Key Terms, Guidelines and
Definitions

STRENGTH THROUGH KNOWLEDGE

Background

Research indicates that the Industrial Modernization Incentives Program (IMIP) is achieving positive results. However, the need for an improved cost benefit reporting system exists.

Research Objectives

The objective of this research is to evaluate the effectiveness of the IMIP and to see if it is reducing weapon systems cost and providing the modernization of the U.S. defense industrial base.

Key Concepts

The following concepts outline the scope of the interview:

- Acquisition cost
- Improved productivity
- Improved item quality
- Advances in state-of-the-art technology
- Degree of technology transfer
- Increased surge/mobilization capability
- Reduction of production leadtime
- Increased plant modernization
- Reduced critical material usage

Key Definitions

1. Acquisition Cost

Total cost to the Air Force of acquiring a complete weapon system. A term used within DOD to denote the aggregation of costs to develop, produce, and deploy a weapon system in its operational environment. It commences with the conceptual phase and is completed when the last unit is delivered to the using command. It excludes all operational activities associated with the mission application of the acquired weapon system. The actual or estimated value of an item or material, or a service in terms of its original cost to the U.S., exclusive of any cost incurred subsequent to acquisition and without regard to the time at which actual acquisition occurred or the method by which financed.

2. Leadtime

The allowance made for the amount of time required to accomplish specific objectives. Leadtime in the acquisition sense refers to the time interval consisting of the total government and contractual effort to define, develop, procure, and produce; test and evaluate; install and checkout; and turnover to a using agency items for the operational inventory.

3. Mobilization

The process by which the armed forces or part of them are brought to a state of readiness for war or other national emergency. This includes assembling and organizing personnel, supplies, and material for active military service. The act of preparing for war or other emergencies through assembling and organizing natural resources. The transformation of industry from its peacetime activity to the fulfillment of the military program necessary to support the national military objectives. It includes the mobilization of materials, labor, capital, productive facilities, and contributory items and services essential to the military programs.

4. Productivity

Measure of the relationship between outputs (amounts of goods and services produced) and inputs (the quantities of labor, capital, and material resources used to produce the outputs).

5. Reliability

The probability that a system, subsystem, or equipment will perform a required function for a specified time period under a given set of conditions. When applied to a method of measurement, reliability is concerned with estimates of the degree to which a measurement is free of

random or unstable error. A measure is reliable to the degree that it supplies consistent results.

6. Service Life

The total usefulness of the item in respect to the weapon it supports; that is, from first inception of the weapon until final phaseout.

7. Surge Capability

Refers to the expansion of military production within a peacetime environment -- without declaration of a national emergency. A surge of the defense industrial base is typically represented by a 50 percent increase in production within 12 months.

8. Technology Transfer

The mechanism by which the benefit of taxpayer money invested in IMIP can be multiplied many times. Through this mechanism, other manufacturing firms and other DOD programs benefit from the new technologies and concepts that are developed and proven. Future expenditures of development dollars to reinvest existing technology are avoided and the cost savings from productivity investments are potentially multiplied many times.

9. Validity

Ability of a research instrument to measure what it is purported to measure and the extent to which it provides adequate coverage of the topic under study.

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UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE

AD-A174374

REPORT DOCUMENTATION PAGE

1a. REPORT SECURITY CLASSIFICATION UNCLASSIFIED			1b. RESTRICTIVE MARKINGS		
2a. SECURITY CLASSIFICATION AUTHORITY			3. DISTRIBUTION/AVAILABILITY OF REPORT Approved for public release; distribution unlimited.		
2b. DECLASSIFICATION/DOWNGRADING SCHEDULE			5. MONITORING ORGANIZATION REPORT NUMBER(S)		
4. PERFORMING ORGANIZATION REPORT NUMBER(S) AFIT/GLM/LSM/86S-81			7a. NAME OF MONITORING ORGANIZATION		
6a. NAME OF PERFORMING ORGANIZATION School of Systems and Logistics		6b. OFFICE SYMBOL (If applicable) AFIT/LSP	7b. ADDRESS (City, State and ZIP Code)		
6c. ADDRESS (City, State and ZIP Code) Air Force Institute of Technology Wright-Patterson AFB, Ohio 45433-6583			8b. OFFICE SYMBOL (If applicable)		
8a. NAME OF FUNDING/SPONSORING ORGANIZATION		9. PROCUREMENT INSTRUMENT IDENTIFICATION NUMBER			
8c. ADDRESS (City, State and ZIP Code)		10. SOURCE OF FUNDING NOS.			
11. TITLE (Include Security Classification) See Box 19		PROGRAM ELEMENT NO.	PROJECT NO.	TASK NO.	WORK UNIT NO.
12. PERSONAL AUTHOR(S) David E. Spenny, B.S., Captain, USAF					
13a. TYPE OF REPORT MS Thesis	13b. TIME COVERED FROM _____ TO _____	14. DATE OF REPORT (Yr., Mo., Day) 1986 September		15. PAGE COUNT 87	
16. SUPPLEMENTARY NOTATION					
17. COSATI CODES		18. SUBJECT TERMS (Continue on reverse if necessary and identify by block number)			
FIELD 01	GROUP 03	Aircraft Industry Industrial Production Technology Transfer Technology Modernization			
19. ABSTRACT (Continue on reverse if necessary and identify by block number)					
<p>Title: AN EVALUATION OF THE EFFECTIVENESS OF THE INDUSTRIAL MODERNIZATION INCENTIVES PROGRAM (IMIP)</p> <p>Thesis Advisor: William C. Pursch, Ph.D. Professor of Contracting Management and Department Head</p> <p>Approved for public release LAW AFB 180-17 by [Signature] 2c Sept 86 Director for Research and Professional Development Air Force Institute of Technology (AFIT) Wright-Patterson AFB OH 45433</p>					
20. DISTRIBUTION/AVAILABILITY OF ABSTRACT UNCLASSIFIED/UNLIMITED <input type="checkbox"/> SAME AS RPT. <input type="checkbox"/> DTIC USERS <input type="checkbox"/>		21. ABSTRACT SECURITY CLASSIFICATION UNCLASSIFIED			
22a. NAME OF RESPONSIBLE INDIVIDUAL William C. Pursch, Ph.D.		22b. TELEPHONE NUMBER (Include Area Code) 513-255-3944	22c. OFFICE SYMBOL AFIT/LSP		

The Industrial Modernization Incentives Program (IMIP) is the first significant DOD attempt to provide a catalyst for defense contractors to modernize the defense industrial base. IMIP evolved from the Air Force's Technology Modernization (TECHMOD) program that was designed to reduce weapon systems cost and strengthen the industrial base. While IMIP is maturing since its 1982 beginnings, standardized criteria for evaluating its effectiveness have been lacking.

This second stage of research is built upon the study completed by Cooper and Houck, Measuring the Effectiveness of the Industrial Modernization Incentives Program. They identified nine criteria that were validated as useful tools in evaluating the effectiveness of IMIP. During the second stage, these criteria were applied to selected IMIP projects to see if IMIP reduces weapons systems cost and modernizes the U.S. defense industrial base. The nine criteria were rephrased into nine investigative questions. Results of the research indicate that two of the nine should always be used on a selected basis depending on the project being evaluated.

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